

**Ocean Optics Protocols For Satellite Ocean Color Sensor
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Protocols and Appendices**

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Chapter 5

Stray-Light Correction of the Marine Optical Buoy

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5.1 INTRODUCTION

In ocean-color remote sensing, approximately 90 % of the flux at the sensor originates from atmospheric scattering, with the water-leaving radiance contributing the remaining 10 % of the total flux. Consequently, errors in the measured top-of-the atmosphere radiance are magnified a factor of 10 in the determination of water-leaving radiance. Proper characterization of the atmosphere is thus a critical part of the analysis of ocean-color remote sensing data. It has always been necessary to calibrate the ocean-color satellite sensor vicariously, using *in situ*, ground-based results, independent of the status of the pre-flight radiometric calibration or the utility of on-board calibration strategies (Gordon 1998). Because the atmosphere contributes significantly to the measured flux at the instrument sensor, both the instrument and the atmospheric correction algorithm are simultaneously calibrated vicariously.

The Marine Optical Buoy (MOBY) (Clark *et al.* 1997; Clark *et al.* 2002a; Clark *et al.* 2002b), deployed in support of the Earth Observing System (EOS) since 1996, serves as the primary calibration station for a variety of ocean-color satellite instruments, including the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) (Barnes *et al.* 2000), the Moderate Resolution Imaging Spectroradiometer (MODIS) (Esaiaes *et al.* 1998), the Japanese Ocean Color Temperature Scanner (OCTS) (Isaacman *et al.* 1999), and the French Polarization and Directionality of the Earth's Reflectances (POLDER) (Deschamps *et al.* 1994). MOBY is located off the coast of Lanai, Hawaii. The site was selected to simplify the application of the atmospheric correction algorithms (Clark *et al.* 1997). Vicarious calibration using MOBY data allows for a thorough comparison and merger of ocean-color data from these multiple sensors (Wang *et al.* 2002).

MOBY uses an instrument known as the Marine Optical System (MOS) to detect radiation over the spectral range from 350 nm to 955 nm. The MOS system contains two single-grating spectrographs, a blue spectrograph (BSG) to measure light in the near ultraviolet and visible from 340 nm to 640 nm and a red spectrograph (RSG) to measure light in the red and near infrared from 550 nm to 955 nm (Clark *et al.* 2002a; Clark *et al.* 2002b). MOS resides in the MOBY instrument bay located at the bottom of the buoy. It is connected by optical fibers to radiance and irradiance ports on the three MOBY arms (denoted Top, Mid, and Bot), located at different ocean depths (typically 1.5 m, 5 m and 9 m), as well as to a surface irradiance port. MOBY measures upwelling radiance, L_u , as well as the down-welling irradiance, E_d . A fiber-optic multiplexer in the MOBY instrument bay selects which spectrum is acquired by MOS. As described in Clark *et al.* (2002b), these data are used to determine the water-leaving radiance, L_w .

MOBY buoys are typically deployed for 3 months to 4 months, then retrieved for servicing and repair. Deployments are numbered sequentially. One MOS instrument, MOS204, is used for even-buoy deployments while a separate instrument, MOS205, is used for odd deployments. The buoys are calibrated before and after deployment using sources traceable to radiometric standards maintained at the National Institute of Standards and Technology (NIST) (Clark *et al.* 2002a). During a deployment, the buoy's radiometric stability is checked using on-board calibration sources and monthly lamp calibrations by divers (Clark *et al.* 2002a). The MOBY radiometric standards are monitored during the year using two single-channel filter radiometers, called Standard Lamp Monitor (SLM) radiometers, with filter channels at 412 nm and 870 nm. They are calibrated at NIST on a regular basis. In addition, transfer-standard artifacts are deployed from NIST to the MOBY field laboratory on a yearly basis to validate the calibration protocols and assess the accuracy and stability of the MOBY spectral radiance sources.